wherein an amount of sodium contained within the wiring is equal to or less than 0.3 ppm, and

wherein internal stress of the wiring comprising tungsten is from $-1x10^{10}$ dyn/cm^2 to $+1x10^{10}$ dyn/cm^2.

REMARKS

We are in receipt of the Office Action of December 20, 2001, and the accompanying Amendment and following remarks are made in light thereof.

Claims 1-63 are pending in the application, with claims 53-63 having been withdrawn from consideration pursuant to a restriction requirement.

In the Office Action, claims 1-52 stand rejected as being either anticipated by or obvious in view of U.S. Patent No. 4,770,948 to Oikawa et al. The Examiner also found the Oath to be defective and requested that a new Oath be submitted. Such an Oath accompanies this Response.

The present invention is directed to a semiconductor device having wirings formed over a substrate, the wirings comprising tungsten as a main constituent. The wirings include at least one inert element, 90% or more of which is argon. Additionally, the amount of sodium contained within the wirings is equal to or less than 0.3 ppm. Each of the pending independent claims 1, 4, 16, 28, 40 and 52 has been amended to clarify these features.

In the Office Action, claims 1, 2, 4, 5, 16, 17 are rejected under 35 U.S.C. 102(b) as being anticipated by Oikawa et al., and claims 3, 6-15 and 18-52 are rejected under 35 U.S.C. 103(a) as being unpatentable over Oikawa et al. The Examiner asserts that Oikawa et al. disclose a wiring material (5) comprising tungsten or tungsten compound as a main constituent, wherein at least one

inert element is included within the wiring material and argon is contained in the inert element at an amount equal to or greater than 90%, and wherein an amount of sodium contained within the wiring material is equal to or less than 0.3 ppm.

However, Oikawa et al. fail to teach that the wirings include at least one inert element, and 90% or more of the inert element is argon. That is, since Oikawa et al. do not teach that simple substance gas of Ar (i.e. 100% Ar gas) is used as the sputtering gas, it is not obvious that 90% or more of the inert element included in Oikawa et al.'s gate electrode is argon. Accordingly, Oikawa et al.'s gate electrode 5 is different form the present invention as claimed in claims 1, 4, 16, 28, 40, and 52.

With regard to claim 4, the Examiner asserts that Oikawa et al. disclose a lamination film of thin films selected from the group consisting of the metallic film, the metallic compound film, and the alloy film. However, Applicant cannot find this in the disclosure of Oikawa et al.

With regard to claim 18, the amendment is supported in the specification on page 11, lines 8-16.

Applicant respectfully submits that the claims of the present application are now in condition for allowance, and an early Office Action in this regard is earnestly solicited.

Respectfully submitted,

Stephen B. Heller
Registration No.: 30,181

COOK, ALEX, McFARRON, MANZO
CUMMINGS & MEHLER, LTD.
200 West Adams Street, Suite 2850
Chicago, Illinois 60606
(312)236-8500

VERSION WITH MARKINGS TO SHOW CHANGES MADE

1 (Amended). A semiconductor device comprising:

[wiring material] wirings formed over a substrate, the wirings comprising tungsten or a tungsten compound as a main constituent,

wherein [at least one inert element is include within the wiring material and argon is contained in the inert element at an amount equal to or greater than 90%] the wirings include at least one inert element, and 90% or more of the inert element is argon, and

wherein an amount of sodium contained within the [wiring material] wirings is equal to or less than 0.3 ppm.

3 (Amended). A [wiring material] semiconductor device according to claim 1, wherein electrical resistivity of the [wiring material] wirings is equal to or less than 40 $\mu\Omega$·cm.

4 (Amended). A semiconductor device [having a wiring] comprising:

a metallic film formed over a substrate, the metallic film comprising one element, or a plurality of elements, selected from the group consisting of W, Ta, Ti, Mo, Cr, Nb, and Si; a metallic compound film having said elements as main constituents; an alloy film of a combination of said elements; or a lamination film of thin films selected from the group consisting of said metallic film, said metallic compound film, and said alloy film,

wherein [at least one inert element is include within the wiring and argon is contained in the inert element at an amount equal to or greater than 90%] the metallic film includes at least one inert element, and 90% or more of the inert element is argon, and

wherein an amount of sodium contained within the [wiring material] metallic film is equal to or less than 0.3 ppm.

5 (Amended). A device according to claim 4, [wherein the wiring is formed by a sputtering method using argon as a sputtering gas] further comprising a semiconductor film adjacent to the metallic film with an insulating film interposed therebetween.

6 (Amended). A device according to claim 4, wherein [an] the inert element [other than] except for argon is contained within the [wiring] metallic film at an amount equal to or less than 1 atom%.

7 (Amended). A device according to claim 4, wherein [an] the inert element [other than] except for argon is contained within the [wiring] metallic film at an amount equal to or less than 0.1 atom%.

8 (Amended). A device according to claim 4, wherein the inert element [other than] except for the argon is Xe or Kr.

9 (Amended). A device according to claim 4, wherein internal stress of the metallic film is from -1×10^{10} dyn/cm^2 to $\pm1\times10^{10}$ dyn/cm^2.

10 (Amended). A device according to claim 4, wherein line width of the [wiring] metallic film is equal to or less than 5 μm.

11 (Amended). A device according to claim 4, wherein film thickness of the [wiring] metallic film is equal to or greater than 0.1 μm, and equal to or less than 0.7 μm.

12 (Amended). A device according to claim 4, wherein the [wiring] metallic film is used as a gate wiring of a TFT.

13 (Amended). A device according to claim 4, wherein resistance value per 1 square μm of surface area of a connection between the [wiring] metallic film and an aluminum wiring is equal to or less than 40 Ω.

14 (Amended). A device according to claim 4, wherein the semiconductor device is selected from the group consisting of an active matrix type liquid crystal display, an active matrix type EL display, [or] and an active matrix type EC display.

15 (Amended). A device according to claim 4, wherein the semiconductor device is at least one electric device selected from the group consisting of a video camera, a digital camera, a projector, a goggle type display, a car navigation system, a personal computer, [or] and a portable information terminal.

16 (Amended). A semiconductor device [having a wiring] comprising:

a film [having] formed over a substrate, the film comprising tungsten or a tungsten compound as a main constituent; and

an insulating film formed over the film, said insulating film comprising SiOxNy,

wherein [at least one inert element is include within the wiring and argon is contained in the inert element at an amount equal to or greater than 90%] the film includes at least one inert element, and 90% or more of the inert element is argon, and

wherein an amount of sodium contained within the [wiring material] film is equal to or less than 0.3 ppm.

17 (Amended). A device according to claim 16, [wherein the wiring is formed by a sputtering method using argon as a sputtering gas] further comprising a semiconductor film adjacent to the film comprising tungsten with an insulating film interposed therebetween.

18 (Amended). A device according to claim 16, wherein [an] the inert element [other than] except for argon is contained within the [wiring] film at an amount equal to or less than 1 atom%.

19 (Amended). A device according to claim 16, wherein [an] the inert element [other than] except for argon is contained within the [wiring] film at an amount equal to or less than 0.1 atom%.

20 (Amended). A device according to claim 16, wherein the inert element [other than the] except for argon is Xe or Kr.

21 (Amended). A device according to claim 16, wherein internal stress of the tungsten film or of the film [having] comprising the tungsten compound as its main constituent is from -1×10^{10} dyn/cm^2 to $\pm 1 \times 10^{10}$ dyn/cm^2.

22 (Amended). A device according to claim 16, wherein line width of the [wiring] film is equal to or less than 5 μm.

23 (Amended). A device according to claim 16, wherein [film] the thickness of the [wiring] film is equal to or greater than 0.1 μm, and equal to or less than 0.7 μm.

24 (Amended). A device according to claim 16, wherein the [wiring] film is used as a gate wiring of a TFT.

25 (Amended). A device according to claim 16, wherein resistance value per 1 square μm of surface area of a connection between the [wiring] film and an aluminum wiring is equal to or less than 40 Ω.

26 (Amended). A device according to claim 16, wherein the semiconductor device is selected from the group consisting of an active matrix type liquid crystal display, an active matrix type EL display, [or] and an active matrix type EC display.

27 (Amended). A device according to claim 16, wherein the semiconductor device is at least one electric device selected from the group consisting of a video camera, a digital camera, a

projector, a goggle type display, a car navigation system, a personal computer, [or] and a portable information terminal.

28 (Amended). A semiconductor device comprising:

a wiring formed over a substrate having a lamination structure comprising a film [having] comprising tungsten or a tungsten compound as a main constituent, and a nitride film of tungsten,

wherein [at least one inert element is include within the wiring and argon is contained in the inert element at an amount equal to or greater than 90%] the film comprising tungsten includes at least one inert element, and 90% or more of the inert element is argon, and

wherein an amount of sodium contained within the wiring [material] is equal to or less than 0.3 ppm.

29 (Amended). A device according to claim 28, wherein the wiring [is formed by a sputtering method using argon as a sputtering gas] further comprises a semiconductor film adjacent to the wiring with an insulating film interposed therebetween.

30 (Amended). A device according to claim 28, wherein [an] the inert element [other than] except for argon is contained within the wiring at an amount equal to or less than 1 atom%.

31 (Amended). A device according to claim 28, wherein [an] the inert element [other than] except for argon is contained within the wiring at an amount equal to or less than 0.1 atom%.

32 (Amended). A device according to claim 28, wherein the inert element [other than the] except for argon is Xe or Kr.

33 (Amended). A device according to claim 28, wherein internal stress of the tungsten film or of the film having the tungsten compound as its main constituent is from -1×10^{10} dyn/cm^2 to $\pm 1 \times 10^{10}$ dyn/cm^2.

38 (Amended). A device according to claim 28, wherein the semiconductor device is selected from the group consisting of an active matrix type liquid crystal display, an active matrix type EL display, [or] and an active matrix type EC display.

39 (Amended). A device according to claim 28, wherein the semiconductor device is at least one electric device selected from the group consisting of a video camera, a digital camera, a projector, a goggle type display, a car navigation system, a personal computer, [or] and a portable information terminal.

40 (Amended). A semiconductor device comprising:

a wiring formed over a substrate, the wiring having a lamination structure containing a silicon film having an added impurity element for imparting conductivity, a film [having] comprising tungsten or a tungsten compound as a main constituent, and a nitride film of tungsten,

wherein [at least one inert element is include within the wiring and argon is contained in the inert element at an amount equal to or greater than 90%] the film comprising tungsten includes at least one inert element, and 90% or more of the inert element is argon, and

wherein an amount of sodium contained within the wiring [material] is equal to or less than 0.3 ppm.

41 (Amended). A device according to claim 40, [wherein the wiring is formed by a sputtering method using argon as a sputtering gas] further comprising a semiconductor film adjacent to the wiring with an insulating film interposed therebetween.

42 (Amended). A device according to claim 40, wherein [an] the inert element [other than] except for argon is contained within the wiring at an amount equal to or less than 1 atom%.

43 (Amended). A device according to claim 40, wherein [an] the inert element [other than] except for argon is contained within the wiring at an amount equal to or less than 0.1 atom%.

44 (Amended). A device according to claim 40, wherein the inert element [other than the] except for argon is Xe or Kr.

45 (Amended). A device according to claim 40, wherein internal stress of the tungsten film or of the film having the tungsten compound as its main constituent is from $-1x10^{10}$ dyn/cm^2 to $\pm 1x10^{10}$ dyn/cm^2.

50 (Amended). A device according to claim 40, wherein the semiconductor device is selected from the group consisting of an active matrix type liquid crystal display, an active matrix type EL display, [or] and an active matrix type EC display.

51 (Amended). A device according to claim 40, wherein the semiconductor device is at least one electric device selected from the group consisting of a video camera, a digital camera, a projector, a goggle type display, a car navigation system, a personal computer, [or] and a portable information terminal.

52 (Amended). A semiconductor device comprising:

a wiring comprising tungsten formed over a substrate,

wherein [at least one inert element is include within the wiring and argon is contained in the inert element at an amount equal to or greater than 90%] the wiring includes at least one inert element, and 90% or more of the inert element is argon,

wherein an amount of sodium contained within the wiring [material] is equal to or less than 0.3 ppm, and

wherein internal stress of the [film] wiring comprising tungsten is from $-1x10^{10}$ dyn/cm^2 to $\pm 1x10^{10}$ dyn/cm^2.